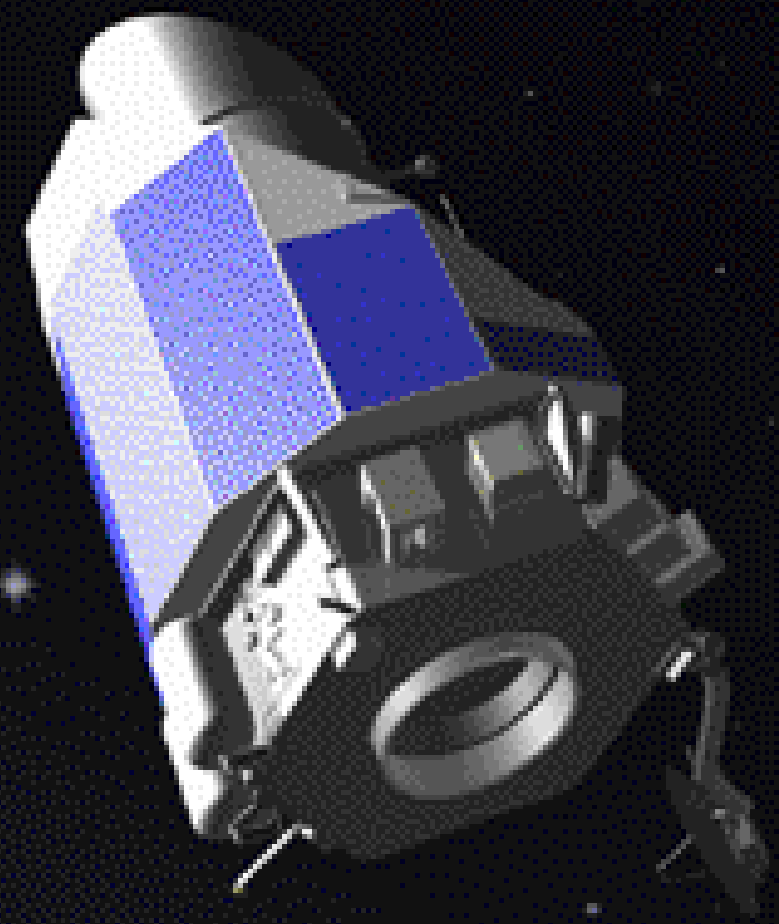
KEPLER



William Borucki
Principal Investigator
NASA Ames Research Center
February 25, 2002

SCIENCE TEAM

William J. Borucki, PI, and David Koch, Deputy PI

Stellar Occultations & High-Precision CCD Photometry

- Timothy Brown, HAO, UCAR
- Edward Dunham, Lowell Obs.
- John Geary, SAO
- Ronald Gilliland, STScI
- Steve Howell, U. Ariz
- Jon M. Jenkins, SETI Institute

Doppler Velocity Planet Searches

- William Cochran, UTexas
- David Latham, SAO
- Geoff Marcy, U. Cal., Berkeley

Stellar Variability

- Gibor Basri, U. Cal., Berkeley
- Andrea Dupree, SAO
- Dmiter Sasselov, Harvard

Theoretical Studies

- Jack Lissauer, NASA Ames
- Alan Boss, Carneige Institute Wash.

Mission Operations

- Donald Brownlee, U. of Washington
- Yoji Kondo, NASA GSGC

General Overview

- John Caldwell, York U.
- David Morrison, NASA Ames
- Tobias Owen, U of Hawaii
- Harold Reitsema, Ball Aerospace Co.
- Jill Tarter, SETI Institute

Education and Public Outreach

- Edna DeVore, SETI Institute
- Alan Gould, Lawrence Hall of Science

SCIENTIFIC GOALS

- Determine the frequency of terrestrial and larger planets in or near the habitable zone of a wide variety of stellar spectral types
- Determine the distribution of sizes and semi-major axes of these planets
- Identify additional members of each photometrically discovered planetary system using complementary techniques
- Determine the distributions of semi-major axis, albedo, size, and density of short-period giant planets
- Estimate the frequency of planets orbiting multiple star systems
- Determine the properties of those stars that harbor planetary systems

MISSION OVERVIEW

Important Science

- Frequency of Earth-size planets in the habitable zone
- Comparison of solar system with other planetary systems
- Association of planetary systems with stellar types

Experienced Organizations

- Ames does science analysis and transit detection
- Ball develops spacecraft and instruments
- Honeywell performs mission operations
- STScI calibrates and archives the data
- SAO selects targets and validates discoveries

Low Risk

- No new technology
- Vulcan observations prove analysis software
- Kepler testbed results prove Earth-size transits can be detected
- Single prime contractor

Simple Mission

- PI led mission
- Single instrument
- Few moving parts; no selectable gratings, filters, etc.
- No critical maneuvers

MISSION DESIGN

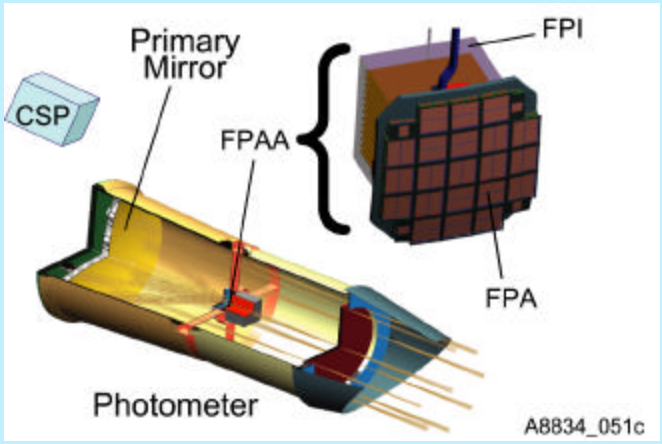
KEPLER: A Wide FOV Telescope that Monitors 100,000 Stars for 4 years with Enough Precision to Find Earth-size Planets in the HZ

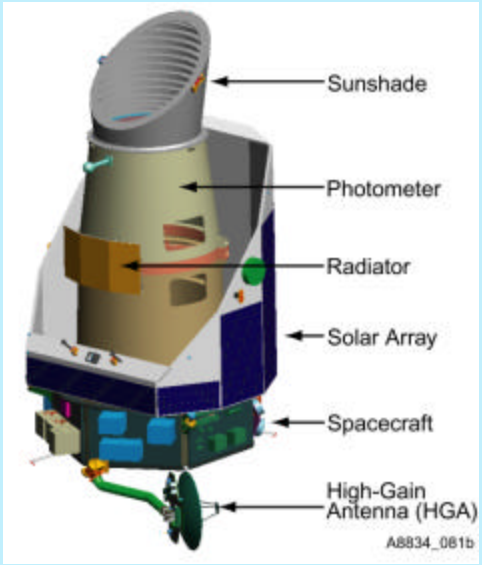
Use transit photometry to detect Earth-size planets

- **0.95 meter aperture provides enough photons**
- **Observe for several years to detect the pattern of transits**
- **Monitor stars continuously to avoid missing transits**
- **Use heliocentric orbit**

Get statistically valid results by monitoring 100,000 stars

- **Use wide field of view telescope**
- **Use a large array of CCD detectors**

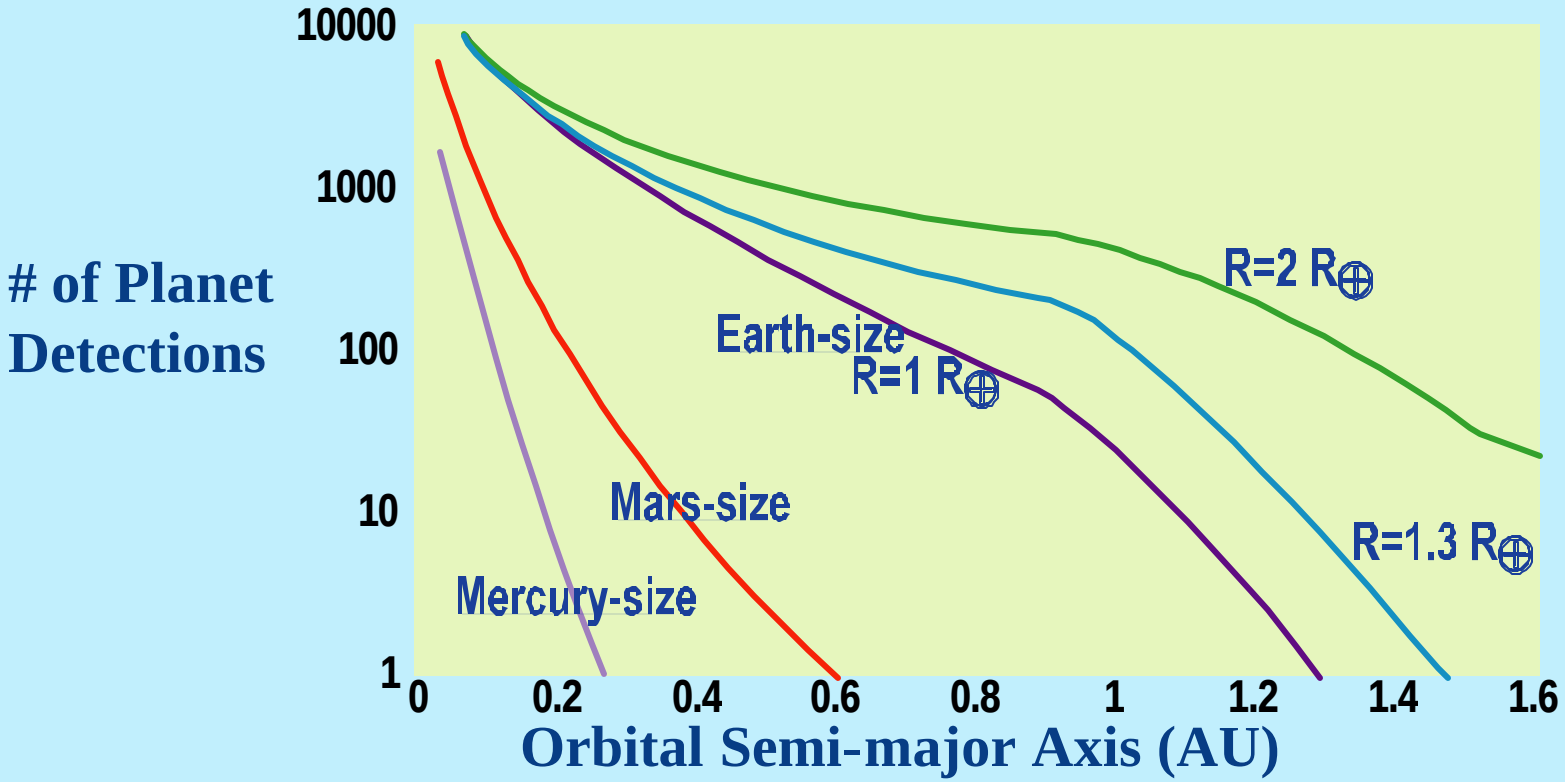




21 CCD Modules are the Heart of the Kepler Mission

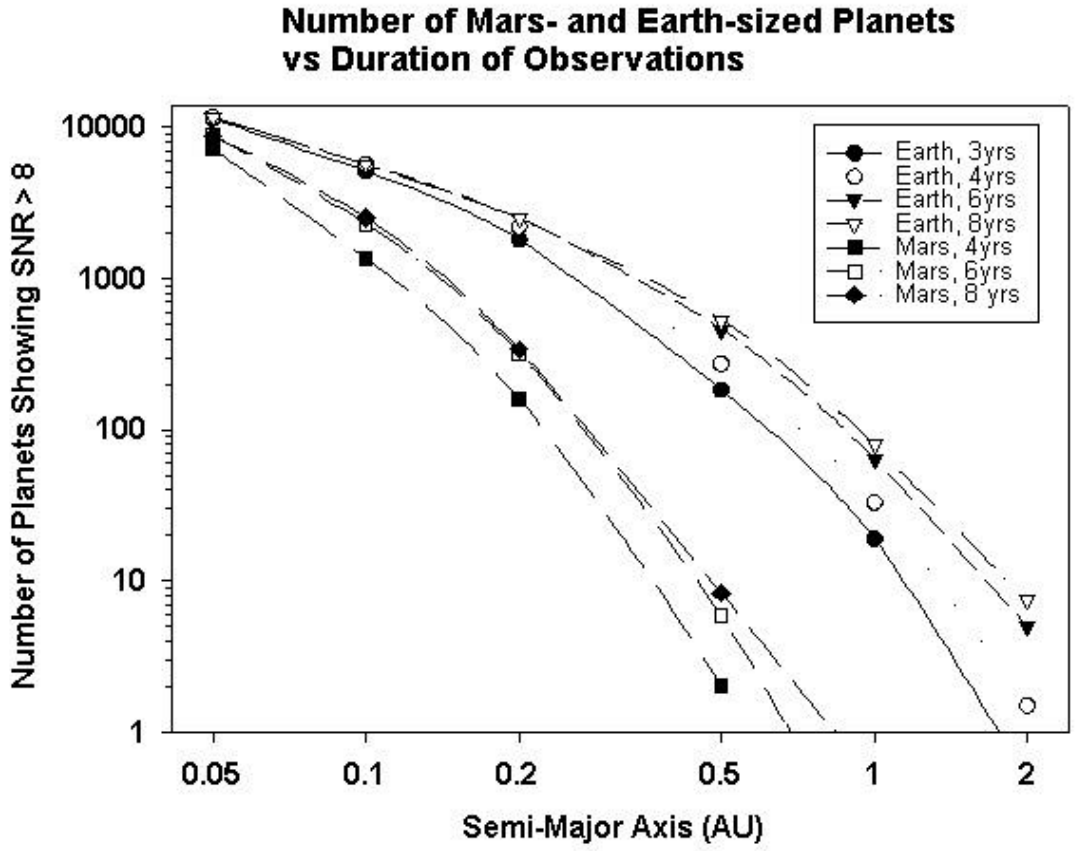
SCIENCE DRIVER

Statistically valid result for abundance of Earth-size planets in habitable zone



Expected # of planets found, assuming one planet of a given size & semi-major axis per star and random orientation of orbital planes.

RESULTS FROM AN EXTENDED MISSION



WB/lct

OPERATIONS ORGANIZATION

Science Ops Center - Ames
- Scientific direction
- Select target stars
- Manage Instrument
- Diff. ensemble photometry
- Stellar light curves
- Transit search
- Candidate planet list
- Direct follow-up observing
- Final planet determination

Sustaining Engneering - Ball Aerospace
- Manage MOC
- Ensure spacecraft health/safety
- Anomaly resolution

Mission Ops Center - Honeywell
- Cmd/control spacecraft
- DSN scheduling
- Acquire all data
- Engr. data archive
- Anomaly response

Complementary Observing - SAO/UA/UC-B
- Stellar classification
- Elim. false positives
  - low resolution spectroscopy
- Stellar properties
- Giant planet mass
  - high resolution spectroscopy

Data Management Center - STScI
- Calibrate data
- Archive data
- Difference images
- HST follow-up
- PSP and DAP

Education Public Outreach - LHS/SETI
- Formal education
- Informal education
- Public outreach

Observ-ing request

Stellar data

Target list

Calibrated data

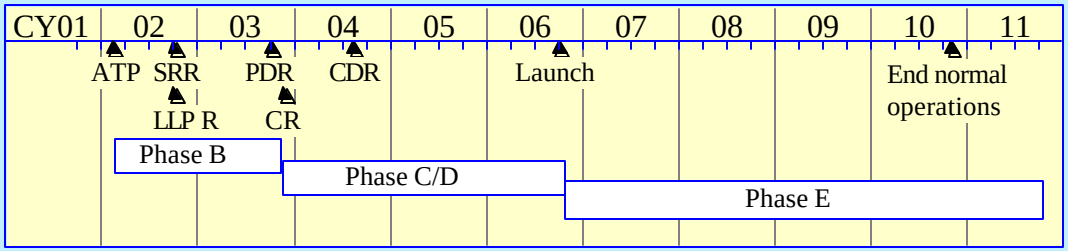
Results

Raw data

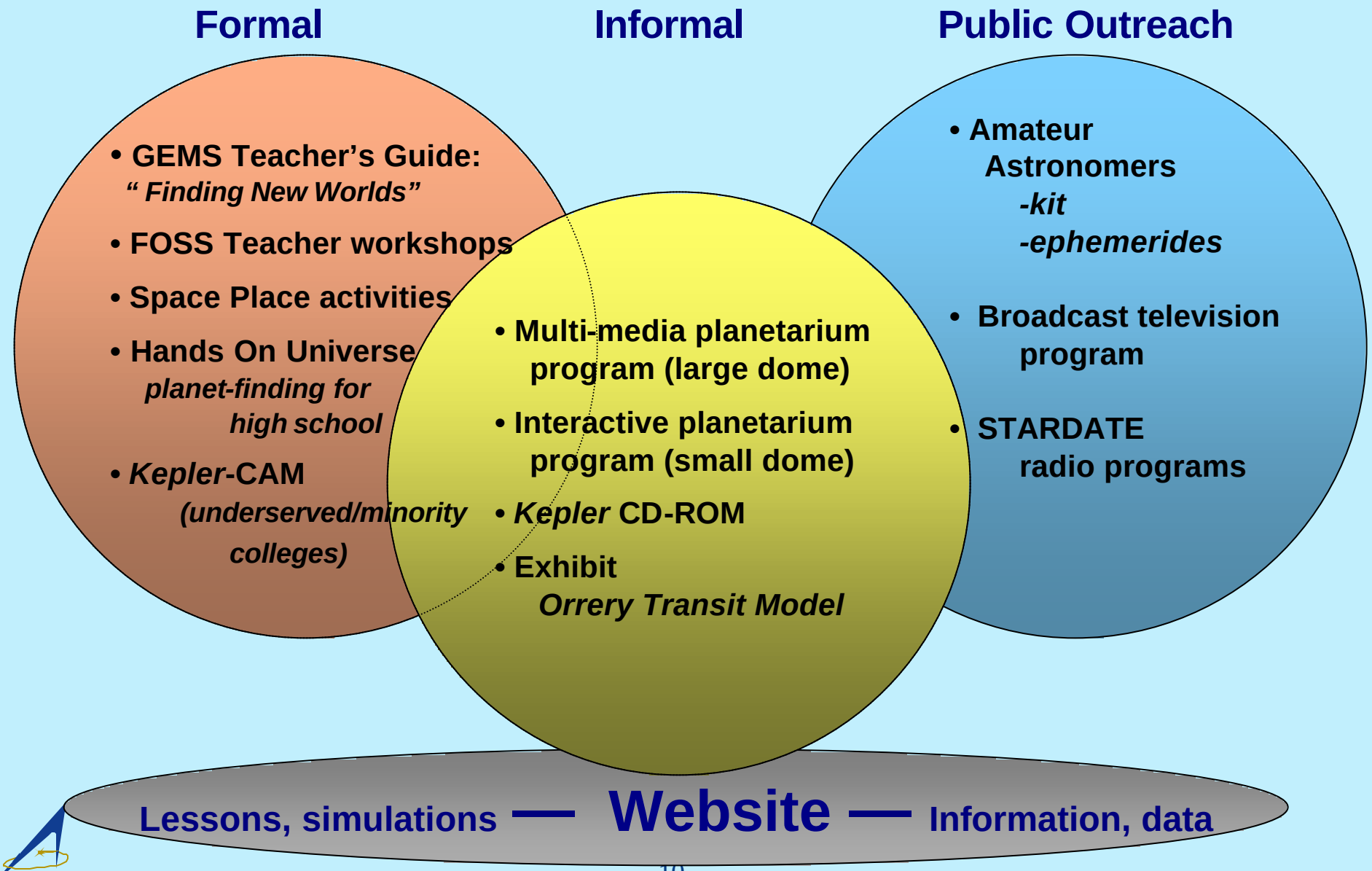
Cmd/data

DSN

SCHEDULE


CY01
02
03
04
05
06
07
08
09
10
11
ATP
SRR
LLP R
PDR
CR
CDR
Launch
End normal operations
Phase B
Phase C/D
Phase E

Kepler E/PO COMPONENTS



PROGRESS OVER PAST YEAR

January 2001: Discovery Program selects the *Kepler* Mission as one of three finalists.

March 2001: Funding received to develop a Concept Study Report.

July 24, 2001: Concept Study Report submitted to NASA HQ.

September 4, 2001: Site review conducted at Ball Aerospace.

December 21, 2001: Discovery Program selects the *Kepler* Mission for Phase B studies.

January 2002: Discussions with HQ to define Phase B funding profile.

February 2002: Funding received to start Phase B studies.